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Estimated the Willingness to Pay Levels for the Adoption of the Internet of Things-IoTs Technology: An Empirical Study in Swiftlet Farming in Binh Thuan Province, Vietnam

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Abstract

Imported into Vietnam since 2005, domestic swiftlet farming has been being received, noticed, and invested by various stakeholders and multi-local government levels. Entering the digital era, digital technologies are amending the farming of swiftlet and the application of the Internet of Things-IoT technology along with Artificial Intelligence-AI is expanding rapidly. IoTs and Artificial Intelligent positively support farmers in order to collect, synthesize and analyze statistics of data, to be able to self-control, adjust the behavior of the farming activities based on precisely dosed indicators to limit the potential risks due to the enemies of the swiftlet or the bad guys stealing bird's nest. This study investigated 120 producers in Phan Thiet, Ham Thuan Bac, and Bac Binh where the highest population of swiftlet activity in Binh Thuan province, Vietnam. The study applies the Willingness to Pay method in combining with the Linear Regression Model (LRS) to estimate the level of the Willingness to Pay (WTP) and its determinants for the adoption of the Internet of Things (IoTs) technology. The findings indicated that producers agreed to pay 380 million VND (nearly 30% of total investment in equipment and technology) but the level of the WTP showed a large variation: 55 million of lowest group and while more than 1200 million of the highest one. The LRS model with 12 explanatory variables allowed to explain 51% of the factors' influence on the WTP. The findings indicated that should be taken into account the multi-aspects of solutions from producers, enterprises and local government achieve sustainable development in swiftlet farming.

Keywords: WTP; IOTs technology; swiftlet farming, empirical study, sustainable development

1. Introduction

The swiftlet Aerodramus fuciphagus (Ho Thi Loan, 2015) is a wild bird, nesting naturally in the island caves. In Vietnam, those kinds of bird have two subspecies: Aerodramus fuciphagus germanium (Comitee, 2017) and Aerodramus fuciphagus amechanus (Bach Phuong, 2018). In recent years, the swiftlet farming has been formed. In Vietnam, the swiftlet concentrates mainly in the coastal provinces of the country from Thanh Hoa to Ca Mau. In 2017, the Prime Minister issued Decision No. 553 / QD-TTg dated April 21, 2017 approved the plan for bio-industry development up to 2030, including related contents to the swiftlet (Comitee, 2017). Based on the legal basis and scientific evidence, submitting to the Prime Minister for approval Vietnamese Swiftlet is a national product is very necessary and can be developed toward the oversea market. Currently, the total supply have been satisfied around 50% for the global demand. According to the Vietnam Swiftlet Farmer's Association (VSFA), currently, there are 41 provinces and cities that have swiftlet houses. Places with rapid growth in construction such as Phu Yen, Binh Thuan (increase 10-12% / month), Rach Gia, Ha Tien cities (Kien Giang), Phan Rang - Thap Cham (Ninh Thuan) increased by over 12%. Industry experts estimate that Vietnam currently has no less than 11,000 swiftlet houses, with social capital invested in this industry nearly 18,000 billion VND. From 2015 onwards, the total farming floor area was approximately estimated at 2,350,000 m2 (Thanh Nhan, 2019). Currently, the swiftlet farming mainly creates artificial habitats such as temperature, humidity, light ... similar to natural conditions to attract swiftlets to live, nest, and reproduce. Therefore, the swiftlet farmers need

to calculate and design the swiftlet house to ensure the appropriate micro-environment, use the method of seduction (sound, the smell of the herd ...), but based on experience is primarily.

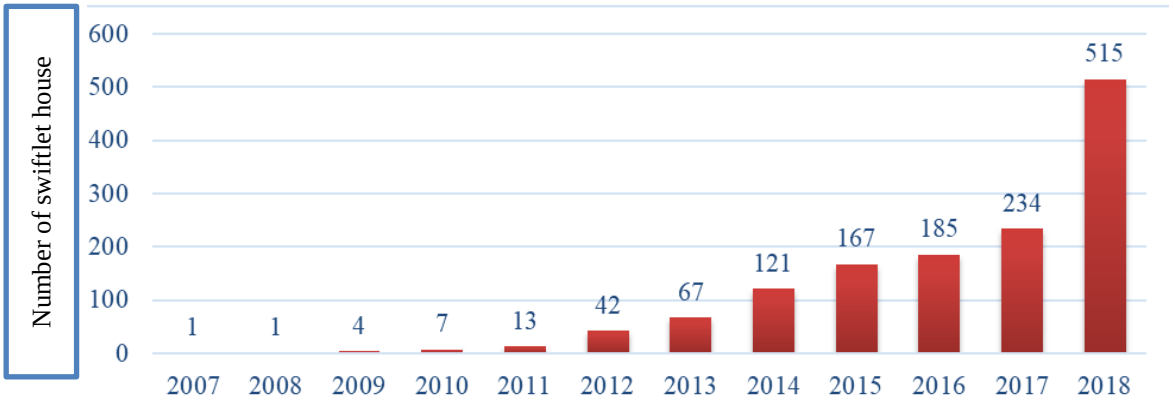


Figure 1. Number of swiftlet houses in Binh Thuan province, 2007-2018
(Binh Thuan's People commitee, 2019)

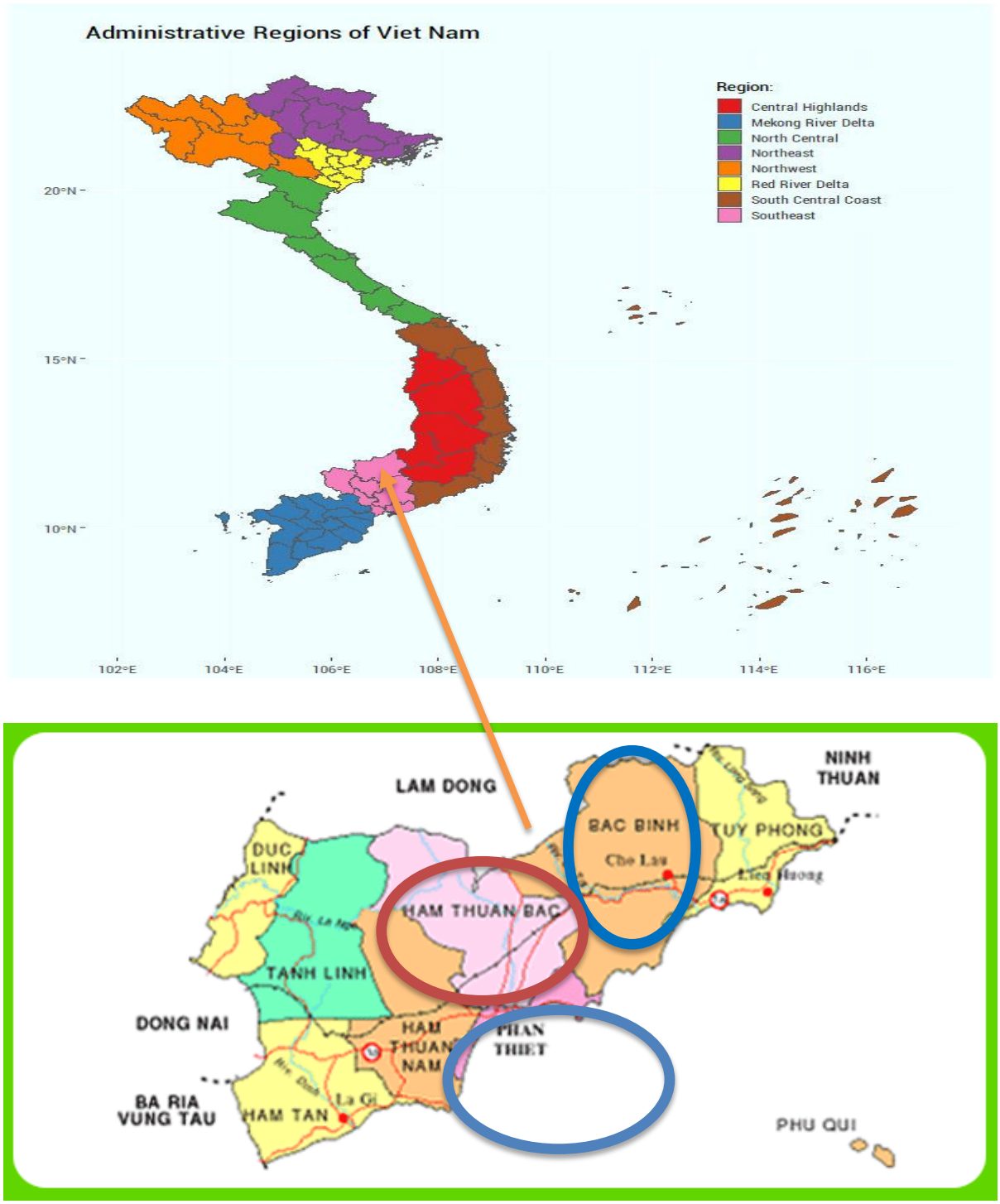
Binh Thuan is the second-largest homeland of swiftlet farming. This sector has been early started to developing since 2007 and extending dramatically in recent years (Figure 1). Thank to the potentially advanced conditions, this province has more chances of developing swiftlet farming recently and being one of the leading localities of Vietnam in domain of swiftlet herds (Do Van Hoan, 2018; Binh Thuan's People commitee, 2019; Le Cuc, 2019). Information from Figure 1 presents the number of swiftlet houses in Binh Thuan province has increased continuously year by year. The rapid growth clearly showed in the last 5 years because of its economic efficiency and exceptional expectations. The recent successes were a combination of absolutely natural conditions and the rapidly updated science and technology. However, there were limited emperical studies conducted in the fields of IoTs technology in swiftlet farming in Vietnam, especially in the term of market demand, accessibility, the willingness to apply the technology and the level of WTP for using the application. This study focused on two main objectives: (i) to survey the technology market for swiftlet farming, especially estimating farmers' willingness to pay for software and equipment solutions and driving parameters affecting the WTP in applying IoTs; (ii) to propose suitable solutions to promote the development and application of software and equipment solutions package to improve productivity and efficiency of domestic swiftlet farming as well as maintain the stable development of swiftlets farming in Vietnam. The study is expected to achieve important contributions including: to provide scientific and practical arguments on the current situation of swiftlet farming in Vietnam; The application of technology and software solutions in the swiftlet farming is completely new research creating an important foundation for the implementation of further research in other fields in Vietnam and around the world. The findings could be valuable guidelines for policymakers and implementers to have effective orientations for long-term strategy.

The structure of the study includes an introduction describing the current status of swiftlet farming, its objectives and contributions. The next section presents the data and research methods, including the study area, sample size of the survey and methods of processing and analyzing data. The arguments for the explanatory variables included in the model and the expectations of the impact variables on WTP is presented following. The fourth presents the research results and discussions including the description of the WTP level of using the device solution package, the statistics of the results of the variables included in the model, and the results of the model estimation. The final section presents conclusions and recommendations.

2. Sample Size and Research Method

2.1 Materials and Sample Size

The data sources included primary and secondary. In which, the secondary data was collected through literature research annual reports to capture the picture of market supplier for swiftlet farming equipment; the primary data was collected through a prepared questionnaire intended for swiftlet farming households.



Map 1. Binh Thuan province and research areas

This study was carried out in Binh Thuan province, which is one of the localities with the largest number of swiftlet herds as well as the largest number of swiftlet farmers in Vietnam (Comitee, 2017; Do Van Hoan, 2018). To find out the current site as well as the need for technology to monitor and control the swiftlet farming environment in Binh Thuan province, the research team surveyed over 120 swiftlet farming households in the three leading localities for swiftlet farming in Binh Thuan province including Phan Thiet, Bac Binh, Ham Thuan Bac (Map 1). In addition, the study also consulted with 10 experts who were management staff, businessman that providing technology. The questionnaire is designed both opened and closed questions, asking directly about the awareness of IoTs solutions, the demand to use the equipment for monitoring, controlling the nesting environment, and the most necessary parameters that an IoT solution needs to provide.

2.2 Data Progressing

Primary data is directly and carefully adjusted and checked. Then, the final questionnaires were encoded and entered into the prepared template working on Excel and SPSS software for data processing. The statistical methods used include descriptive statistics, multiple-choice statistics, comparison methods.

2.3 Data Analysis

Model of willingness to pay

The research team selected the WTP criterion and proposed a new method to estimate the WTP. This approach works through identifying the needs of using a certain product or service based on different prices to measure the WTP of the interviewees. The Price Estimation (PE) is given, the WTP is the maximum amount people are willing to spend to buy a commodity or enjoy the quality of the improved environment. The WTP is seen as a method to determine the price/ value of the benefit to be received over the current conditions, the WTP also measures the personal or social preference for a certain commodity. The WTP is also the market demand curve for that commodity. This approach has been effectively applied and adopted in the previous studies related to different fields of study with especially in rural and farming activities(Asrat, Belay and Hamito, 2004; Othman *et al.*, 2009; Energyplus, 2011; Divilly, 2018; Etsay, Negash and Aregay, 2019; Shee, Azzarri and Haile, 2019, 2020; Chuang, Wang and Liang, 2020; Kansanga *et al.*, 2020; ÖZSAYIN, 2020).

$$WTPmean = \frac{\sum_{k=1}^{m} WTPk*nk}{\sum_{k=1}^{m} nk} \quad (1)$$

Function of the WTP estimation

In which:

WTPmean: Average WTP of money paying for devices

k: index of WTP levels k = (1-m)

m: WTP levels that people are willing to pay for IoTs devices

nk: number of surveyed samples corresponding to WTPk level

WTPk: WTP level k

Linear regression model

There are two popular approaches could be applied to estimate the level of the WTP include discrete choice and linear regression model (Luqman & Van Belle, 2017; Nigussie et al., 2017; Hsu & Lin, 2018; Carlina & Kusumawati, 2020; Pillai & Sivathanu, 2020). The selection of each method depends closely on the field of study, the availability of data collection, sample size method (Luqman & Van Belle, 2017; Antony et al., 2020; Chuang, Wang, & Liang, 2020). The discrete choice model is common used in the adoption of a service or a technique where the value of the selection is ranked randomly and the collected data allow to classified to follow a standard distribution (Tun Oo, Van Huylenbroeck, & Speelman, 2017; Minh, Hao, & Lebailly, 2020). However, the limitation of this model comes from the completed steps and concrete conditions to estimate the model. While the linear regression has more popular and advanced to estimate the level of the WTP in case the large variation of the sample mean. In this study, the LRM is used to quantify the affect of the driving parameters on the WTP due to the fluctuation of the WTP of different producers acting in swiftlet farming. The regression model has the following form:

$$Y = \boldsymbol{\beta 0} + \boldsymbol{\beta 1 Xi} + \boldsymbol{\varepsilon} \quad (2)$$

Where:

Y: willingness to pay for using software and equipment solution packages

Xi: value of the independent variables (i = 1… n)

β0 intersection point of the regression line and Y axis

β1 coefficient

ε: model error

3. Literature on the IoTs Technology in Swiftlet Farming and Explanation of Driving Parameters of the Empirical Models

3.1 Related Studies on IoTs Technology and Its Application

Balance of demand and supply. According to Azahar Idris (2014), the estimated world business value of bird nests is 10 billion MYR (equivalent to 2.4 billion USD) and the demand for bird nests is very high while the supply reach only 50% needs of the whole world (Idris, Abdullah, & Abd-Rehman, 2014).

Suitable conditions. The location of the swiftlet house and the living environment are two strategic factors that determine the success of swiftlet farming, for example, the construction of swiftlet houses must be in a crowded area with a source of food. The environmental factors must to be noticed when building swiftlet houses are temperature, humidity and light intensity. Besides, according to research by Ibrahim (2018), the factor of wind speed also needs to be considered. Indoor air temperature should be maintained between 26-35℃, relative humidity between 80 and 90%, light intensity below 5 lux (Ibrahim et al., 2018). The installation of a suitable ventilation system and humidifier also assists swiftlet farmers to achieve a favorable environment.

Related studies on environmental control of swiftlet farming. Research by A. K. Othman et al. (2009) applied Wireless Sensor Networks (WSN) system to control environment in swiftlet farming in Sarawak, Malaysia. Research by Djunaidi Tristanto (2011) has built and evaluated the automatic control system to control the temperature and humidity of the swiftlet house to facilitate and effectively raise swiftlets (Othman *et al.*, 2009). This system helps to control and report the state of the bird's nest as well as analyze the relationship between the amount of water brought into the house with temperature and humidity. S. H. Ibrahim et al. (2011) research on controlling ambient temperature and humidity in swiftlet farming in Malaysia using EnergyPlus software. In 2012, Syed Muhammad Mamduh et al. research on odor control system and toxic gas in swiftlet farming using Wireless Sensor Network (WSN). Next, Ahmad Rizan Ibrahim (2018) research on an environmental monitoring and control system using LoRaWan wireless sensor network. In this study, monitoring sensor data includes humidity, temperature, oxygen and light were recorded in a swiftlet house in Terengganu (Malaysia). The changes in humidity, temperature and oxygen were also studied. The IoTs technology and video analytics are used in this project. Studies indicated the right combination of temperature, humidity and oxygen inside the swiftlet house increases the amount of swiftlet nesting. The study provided some valuable findings of the advantages and limitations of current techniques then proposes the advanced know-how of the monitoring system. Research by Munirah Abd Rahman et al. (2018) on the effects of factors such as temperature, air humidity, light, and sound frequency on the success of the swiftlet farming industry in Terengganu, Malaysia. Since then, the research team determined that the nest productivity increased significantly when the environmental factors were controlled including air temperature 30.1^{o}C; the air humidity is 83.7%; 0.16 lux light intensity; sound frequency 47dB (inside) and 68 dB (outside).

Related studies of application Internet of Things-IoT technology. Several studies focused on analyzing the human determinants of accessing the technique and then provide the solutions to distribute and encourage the machine in an efficient way (Hsu & Lin, 2018). While another article proposed to analyze the widen factors affecting the adoption of IoTs technology (Idris, Abdullah, & Abd-Rehman, 2014; Divilly, 2018). Some scholars have made more attempts to carry out the behavior of adopters in the short and long term periods to give the right direction for developing the application for farmers (Kansanga et al., 2020). In addition, they are also taken into the consideration the driving factors of birth rate class, space, communities as well as farming scale classification (Idris, Abdullah, & Abd-Rehman, 2014; Nigussie et al., 2017; Divilly, 2018; Etsay, Negash, & Aregay, 2019; Carlina & Kusumawati, 2020; ÖZSAYIN, 2020). However, there are no exit study related to the use of equipment, estimates of WTP as well as factors affecting the choice of equipment in the swiftlet farming. As a result of these problems, a study aimed at understanding the needs of equipment, estimating the WTP of IoTs machine, and the factors affecting affordability is very important that allow to estimate and measure the market volume as well as the current practice of machine application of producers. The findings and lesson learns from our study could support to provide precise evidences for policy makers, policy implementers as well as enterprises of IoTs machine

3.2 Explanation of Driving Parameters of the Empirical Models

Many different factors influence on the WTP for the application of a good or service. These factors can be classified according to the sources of influence such as internal factors and external factors. Internal factors such as the capacity of the producer /consumer establishment include the size of the labor, the quality of the labor (education level, skills, experience in the consumer manufacturing sector or gender) (Alemu et al., 2020; Antony et al., 2020). External factors include supply markets for products and services, distribution networks, production

and consumption customs, scientific and technological achievements (Divilly, 2018; Flydén & Haglund, 2018; Hsu & Lin, 2018). In addition, the classification of the effects can be based on the origin of capital sources such as natural capital including land size, climatic conditions, weather, physical capital sources such as equipment systems, material infrastructure (electricity system network, roads, school stations); Human capital includes household capacity as mentioned earlier; social capital sources such as participation in organizations like business associations, associations such as farmers' associations, women's unions, other mass organizations as well as support from other social networks; financial capital such as the availability of credit sources (Luqman & Van Belle, 2017). In addition, the group of elements of the infrastructure can be divided into hard infrastructure as mentioned including the electricity system - school - station and soft infrastructure groups such as preferential policy institutions.

Swiftlet farming is an agricultural product with high requirements of technology applications and large capital investment compare to traditionally agricultural products. Moreover, there were diverse factors that could potentially consider taking into account to analyze the level of the WTP for the use of IoTs technology. In this model, a total of 12 factors have been grounded carefully to estimate the WTP of swiftlet farms for the use of software solutions. The group of factors representing the production/consumption capacity of the facility includes the educational level, years of experience and occupation of the facility owner; factors that belong to the level of awareness include the facility's assessment of the status of swiftlet farming, and the assessment of the role of swiftlet farming in terms of income; geographical location are included to explain the differences in ecological characteristics, the impact of policy institutions at the district/city level on swiftlet farming in general, and investment in software solutions; the exposure to different risks in swiftlet farming is expected to increase the probability of investing in software and equipment solutions; The variable representing the type of the swiftlet farming is classified into an extensive and specialized farming type, specifically, extensive farming is based on house improvement, this form is accounted for with a lower total construction investment compared to farming under a specialized farming type, so the type of specialized farming is expected with a higher level of investment in technology solutions. However, the type of extension of farming will lead to negative impacts related to environmental and noise pollution. Understanding technical solutions and software plays an important role in the decision, which in turn relates to the quality and quantity of information supplied to production facilities. The assessment of the quality of information sources from different access sources is presented in another section, in this context, the number of accessible information sources are expected to increase the level of understanding of the equipment solutions, this increases the probability and level of investment.

Table 1. Explanation of variables and sign of expectation

List of variables	Measurement	Sign of expectation
WTP	1000 đ	
X1: Education level	Year	+
X2: Locality		
X21: Phan Thiet	0: Phan Thiet; 1: Bac Binh/ Ham Thuan Bac	+/-
X22: Bac Binh	0: Bac Binh; 1: Phan Thiet/ Ham Thuan Bac	+/-
X3: Years of experience	The year began to raise swiftlets	+
X4: Occupation		
X41: Farmer	0: Farmer; 1: Civil servant / Businessman	+/-
X42: Civil servant	0: Civil servant; 1: Farmer / Businessman	+/-
X5: Assessment of the status of swiftlet farming	0: Not successful; 1: being successful	+/-
X6: Role of swiftlet farming	0: Not the main income; 1: The main income	+/-
X7: The number of swiftlet houses	The number of swiftlet houses	+
X8: Risk	0: No risks; 1: Get risk	+
X9: type of farming	0: extension farming; 1: specialized farming	+
X10: Number of sources of access information	Number of sources of access information about IOT	+

In this study, some important factors were excluded due to the specificity of swiftlet farming. Specifically, the scale of the labor force is not included because swiftlet farming does not consume labor. Gender is eliminated by the same reason as above. The age of the producers is also listed out because it is necessary to invest in this activity with a large capital source, this segment only focuses on the elder who already owns certain assets.

Variables that have attended the training are also excluded because the surveyed results indicate that there were not many training courses related to the use of technology solutions. In addition, due to the research limitation and the duration of the topic, several other influencing factors are also excluded related to institutions, policies, and career planning. These factors are mainly mentioned when assessing the current status of swiftlet farming in another content of this study.

4. Findings and Discussions

4.1 The Classification of WTP Levels for IoTs Devices

In order to estimate the WTP model of swiftlet farms for the use of software solutions and IoTs devices, the first step is to study the level of payment by different groups. Table 2 presented the distribution of WTP of swiftlet farms by three different categories, including the lowest group with the WTP level below 250 million, the second group from 250 to 350 million, the third group from 350-450 million and the third group highest with WTP greater than 450 million VND DONG. The total baseline sample was 120 samples. However, there were several samples do not satisfy the testing conditions, only remaining 74 .

On average, swiftlet farms in Binh Thuan are willing to pay 373 million VND for the application, compared to the total investment cost, this payment is estimated about 30%. However, there is a far divergent in investment level, in particular, the household with the highest investment for the technology is more than 1.2 billion VND while the lowest level is 55 million VND. The finidings also showed that the group with the lowest payment belongs to the type of extension, while the highest group is mostly under the specialized type, which is completely consistent with the reality. The distribution of the WTP was directly distributed across groups quite evenly, the proportion of establishments belongs to group 1st is the lowest at nearly 15% and the average payment level is about 170 million VND. The majority of establishments having the WTP level to main group 2nd and group 3nd are 32.4% and 31.1% respectively with the average level of payment over 300 and 396 million VND. Notably, there is a relatively high percentage of establishments paying for the use of software equipment solutions with 21.6% with an average of more than 615 million and the lowest is VND 465 million.

Table 2. Classification of WTP level

	WTP	Minimum	Mean	Maximum	Sample	Proportion (%)
1	< 250 million dong	55.0	168.6	215.0	11	14.9
2	250 - 350 million dong	265.0	300.6	350.0	24	32.4
3	350 -450 million dong	365.0	396.1	445.0	23	31.1
4	> 450 million dong	465.0	615.9	1215.0	16	21.6
5		55.0	373.8	1215.0	74	100

(Source: survey data in 2020)

4.2 Describe the Characteristics of the Variables in the WTP Model

The next section presents a description of the statistical results of the variables included in the model. The educational level of the owners' swiftlet farms is high, an average of 11.3 years to school nearby, which is much higher than the household in other agricultural sectors that have application solutions devices such as white shrimp farming. As a result of data cross-checking, most owners have a 12/12 educational degree because they are civil servants or businessmen. Moreover, several households have jobs in agriculture specifically dragon fruit cultivation, their educational level is lower.

After rejecting establishments that did not participate in the test, there was a variation in sample structure by locality. The sample was distributed the highest in Ham Thuan Bac district with 43.2% (38%: calculated for 120 samples), Phan Thiet city with 40.5% (26.6% for 120 samples), and the rest in Bac Binh district with 16.2% (35%: for 120 samples). Thus, it can be seen that the sample variation comes from the city of Phat Thiet. The results explain that most of the establishments in the city of Phan Thiet have invested quite well in terms of equipment, so they are not willing to experience a group of new solutions. Besides, more than two remaining districts, Phan Thiet city also has many conditions to access better technology.

Regarding the occupational structure, the highest percentage of people participating in the experience of equipment solutions is the group of Businessman with 41.9%, followed by the group of civil servant 31.1% and the agricultural group is 27%. This is quite appropriate because the group of businessmen and civil servants are more sensitive to new experiences better than those whose main occupation is agriculture. Currently, the swiftlet farming in Binh Thuan province has mostly been operating after 2015, so it is not possible to accurately assess the success and role of swiftlet farming. The owners from the third year onwards can harvest and estimate

investment efficiency; in the 5th year onwards, the revenue will be stable, but the yield depends on many different factors. Research shows that about 52% of swiftlet farms say they have been successful, but only nearly 7% think swiftlet farming is the main source of income. This result has been explained previously, swiftlet farming is only one solution for income diversification and an investment for the future, so the owners do not see this as the main source of income. Most of each establishment only invests in one swiftlet house, especially in some cases it is considered a businessman field and established companies, so there are more swiftlet houses. Risk probability is also likely to affect willingness to pay, which at the current sample size is 12.2%, not much different from 120 samples. Most of the swiftlet houses are invested by type of specialized farming, far away from the houses, only about 10% of the establishments in type of extension. Sources of information to access equipment solutions are quite diverse. An establishment can learn from different sources with an average of four sources to find out information.

Table 3. Description of driving parameters in the WTP model

Variables	Unit	Minimum	Mean	Maximum
WTP	1000 đ	55.0	378.8	1,215.0
X1: education level	Year	8.0	11.3	12.0
X2: Locality				
Bac Binh	%	-	16.2	-
Phan Thiet	%	-	40.5	-
Ham Thuan Bac	%	-	43.2	-
X3: Years of experience	Year	0	4.3	15.0
X4: Occupation				
Farmer	%	-	27.0	-
Civil servant	%	-	31.1	-
Businessman	%	-	41.9	-
X5: Assessment of the status of swiftlet farming	% (being successful)	-	51.4	-
X6: Role of swiftlet farming	% (main income)	-	6.8	-
X7: The number of swiftlet houses	The number of swiftlet houses	1.0	1.3	10.0
X8: Risk	(%) Get risk	-	12.2	-
X9: Type of farming	% (specialized farming)	-	9.5	-
X10: Number of sources of access information	Number of sources of access information	0	4.0	6.0

(Source: survey data in 2020)

4.3 Estimation Results of the WTP Model for Equipment and Software Solution Packages

Table 4 presents the results of estimating the impact of the 10 input variables affect the willingness to pay for the birds nest basis for the application of equipment solutions and technologies. With the adjusted coefficient R^2 value of 0.510, this result explains that the variables included in the model explain 51% of the variation of the WTP value, and other factors such as infrastructure, institutions, and markets, training activities, social organizations, and Businessman explain the remaining 49% of the WTP's variation.

In the total number of variables included in the model consists of 2 variables of the variable area of research and occupation, these are identity variables with 3 attributes, there are 8 variables with no statistical significance including X1- Cultural Level (+), Location - X21 (-), Location - X22 (+), Years of Experience - X3 (-), Occupation - X42 (+), Assessment of the status of swiftlet farming - X5 (-), Number of swiftlet houses - X7 (+), Model of swiftlet farming - X9 (+). This can be said that these variables cannot be used to explain the impact on WTP.

The quotation mark receives two values, the same dimensional impact shows the "+" sign, and the opposite effect shows the "–"sign.

According to the research data, there is no difference in educational level between farming groups so that educational level does not affect WTP. Geography does not affect the WTP because of the experiential

establishments that they had determined the level of investment required for pieces of equipment. Years of experience do not affect decision-making because the owners do not have much experience in this activity. As mentioned above, this activity has only really grown in recent years, and the results of farming activities also depend heavily on the equipment and technical factors. Likewise, the assessment of the status of swiftlet farming does not reflect the results of the swiftlet farming model. The scale of swiftlet farming is relatively evenly, so this variable does not affect WTP. Although the type of specialized farming has a positive value, due to the relatively low proportion of the type of extension farming and dispersal in three study areas, this variable does not explain the variation of WTP.

Table 4. Results of WTP model for swiftlet farms in Binh Thuan

Explanatory variable	Correlation coefficients (β)	t	Sig.
(Constant)	4.288	0.025	0.981
X1: Education level	2.962	0.207	0.836
X21: Phan Thiet	-38.769	-0.664	0.509
X22: Bac Binh	20.522	0.579	0.565
X3: Years of experience	-6.045	-0.984	0.329
X41: Farmer	73.284	1.829	0.072*
X42: Civil servant	45.279	1.053	0.297
X5: Assessment of the status of swiftlet farming	-0.187	-0.005	0.996
X6: Role of swiftlet farming	112.678	1.853	0.069*
X7: The number of swiftlet houses	14.768	1.243	0.219
X8: Risk	108.261	2.187	0.033**
X9: Type of farming	95.040	1.311	0.195
X10: Number of sources of access information	44.300	4.349	0.000***
R Square	0.591		
Adjusted R Square	0.510		
F	7.331		
Sig.	0.000		

(Source: survey data in 2020)

(Note: ***, ** and * significant at 1%, 5% and 10%)

In this model, four variables can explain for the WTP fluctuation including Farmers - X41 (+), Role of swiftlet farming - X6 (+), Risk - X7 (+), and Number of sources of access information - X10 (+). The above variables all have the same directional impact on the variable WTP, the specific impact level will be explained in turn as follows:

Farmers - X41 (+): the value of the coefficient is 73.2, this signifies the willingness to pay of farmers lower than those with the job as civil servants or Businessman a value of 73.2 million VND. This comes from the income of the base group which is farmers lower than the rest. Besides, the activities in the field of traditional agriculture led to the apprehension of risk when investing in an application or a new technology. 0.072 value of sig is meant conclusions about the impact of Farmers for WTP statistical significance with a significance level of 10%.

Role of swiftlet farming - X6 (+): the value of the coefficient is 112.6, this signifies that the owners agree with the view that swiftlet farming is the main source of income that will invest at a higher level of VND112.6 million compared to households that assess this is not the main activity. Similar to the previously explained content, the swiftlet farming activity, although it requires a large investment of capital, but brings huge income. According to the results from the interview experts active in the provision of services construction of the swiftlet house and the supply of equipment, with a swiftlet house after five years, monthly can collect from 1kg or more, it will be valued very large, can be up to more than 40 billion VND. The 0.069 value of sig is meant conclusions about the impact of the Role of swiftlet farming for WTP statistical significance with a significance level of 10%.

Risk – X8 (+), the value of the coefficient is 108.2, this signifies that the owners who have experienced risks in swiftlet farming are willing to pay for the use of new equipment and software solution packages a value of 108.2 million higher than the other group. With a 10% higher probability of risk, it is clear that this will be of great importance in making investment decisions for a new experience that can overcome existing risks. 0.033 value of sig is meant conclusions about the impact of Risk for WTP statistical significance with a significance level of

5%.

Number of sources of access information - X10 (+), the value of the coefficient is 44.3, when an producer has access to more than one source of information than the average of the remaining households, the level of willingness to pay will increase to more 44.3 million VND. As discussed in the above items, for the development of information networks, the farmers will have the opportunity to be more accessible to many suppliers of the IoTs and services not only locally but also internationally. The access to information as well as suppliers and direct effect on the willingness to pay for products and goods services, particularly package of equipment and technology in this study. The 0.033 value of sig is meant conclusions about the impact of the Number of sources of access information for WTP statistical significance with a significance level of 1%.

5. Conclusions and Recommendations

5.1 Conclusions

Through the WTP estimation and research process and model of factors influencing willingness to pay with 74 swiftlet farmers agreeing to participate in trials of software and equipment solution package, the research team came up with the following conclusions:

(i) There is a high percentage of the base is not willing to participate in testing: 36/120 cases (they were satisfied with the existing equipment); (ii) The average level of the WTP for equipment solutions is 380 million VND (nearly 30% of total investment in equipment and technology); (iii) The WTP has a large variation with the lowest level of 55 million and the highest of more than 1200 million; (iv) The estimation model with 12 explanatory variables is included in the model with high significance, explains 51% of the factors' influence on willingness to pay, has 8 variables included in the model, however, there are 8 variables that do not affect WTP, specifically, there are 3 variables having oppositely correlated and 5 variables positively correlated: No difference in the WTP for equipment in terms of education level, age of owner, location of study, assessment of the status of swiftlet farming and number of swiftlet houses; (v) There are 4 variables in the model explaining the variation of WTP with the strong correlation, specifically the occupation, the role of swiftlet, risk and type of swiftlet farming, in which the most influential variable is the number of sources of access information, followed by risk, the role of swiftlet farming and finally the occupation.

5.2 Recommendations

The following solutions should be taken for swiftlet farming activities in Binh Thuan province to achieve good results and stability in the long term: (i) Synchronize the equipment with the same provider instead of that of different vendors; (ii) Focus on developing and supplying equipment packages that the locality needs; (iii) At present, swiftlet farms have not yet gone into the harvest period, so it is necessary to have closely monitored to accurately assess the economic efficiency of this model; (iv) Develop equipment with the function of controlling risks from the outside environment such as natural enemies, cockroaches, ants; (v) Consider to providing a package of equipment to the swiftlet farming households by type of extension farming and environmental impact assessment; (vi) Increase the marketing of the solution package through information channels, especially distributors and suppliers, equipment installers, builders.

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References

Alemu, G. T. et al. (2020). Smallholder farmers' willingness to pay for sustainable land management practices in the Upper Blue Nile basin, Ethiopia. *Environment, Development and Sustainability*. Springer. https://doi.org/10.1007/s10668-020-00835-6.

Antony, A. P. et al. (2020). A review of practice and implementation of the internet of things (IoT) for smallholder agriculture. *Sustainability (Switzerland), 12*(9), 1-19. https://doi.org/10.3390/su12093750

Asrat, P., Belay, K., & Hamito, D. (2004). 'Determinants of farmers' willingness to pay for soil conservation practices in the southeastern highlands of Ethiopia', *Land Degradation & Development, 15*(4), 423-438. https://doi.org/10.1002/ldr.623

Bach Phuong. (2018). *Direction to handle swiftlet farming outside the planning area*. Retrieved April 21, 2020, from http://baoninhthuan.com.vn/news/100321p0c151/huong-xu-ly-nha-nuoi-chim-yen-ngoai-vung-quy-hoach.htm

Binh Thuan's People committee. (2019). Công văn số 2972/SNN-CCCNTY ngày 26/9/2019 về việc báo cáo tình hình chăn nuôi chim yến của địa phương. Binh Thuan.

Carlina, M. F., & Kusumawati, N. (2020). Factors Influencing Consumer's Willingness to Pay for IOT Products in Indonesia: Analysis of Tam and TRI Factors. *The International Journal of Business & Management, 8*(8). https://doi.org/10.24940/theijbm/2020/v8/i8/BM2008-053

Chuang, J. H., Wang, J. H., & Liang, C. (2020). Implementation of internet of things depends on intention: Young farmers' willingness to accept innovative technology. *International Food and Agribusiness Management Review, 23*(2), 253-266. https://doi.org/10.22434/IFAMR2019.0121

Comitee, P. Y. P. (2017). *Decision 1893 / QD-UBND dated 27/10/2017 on planning areas and villages for swiftlet farming in the province to 2020 and orientations to 2030.* Phú Yên, Việt Nam.

Le Cuc. (2019). *Current status and potentials of swiftlet farming*. Retrieved April 21, 2020, from https://www.qdnd.vn/kinh-te/cac-van-de/thuc-trang-va-tiem-nang-nghe-nuoi-yen-575149

Divilly, J. (2018). *Factors affecting the adoption of Agri-IoT in Ireland.*

Energyplus, I. S. H. (2011). *Study on Suitable Construction Materials for Swiftlet Farming Using.*

Etsay, H., Negash, T., & Aregay, M. (2019). Factors that influence the implementation of sustainable land management practices by rural households in Tigrai region, Ethiopia. *Ecological Processes, 8*(1). https://doi.org/10.1186/s13717-019-0166-8

Flydén, P., & Haglund, K. (2018). *Key determinants for user intention to adopt smart home ecosystems.*

Ho Thi Loan. (2015). Genetic relationships of some swiftlet populations living on islands and inland in Vietnam. *Journal of biology, 37*(2), 228-235.

Hsu, C. L., & Lin, J. C. C. (2018). Exploring factors affecting the adoption of internet of things services. *Journal of Computer Information Systems, 58*(1), 49-57. https://doi.org/10.1080/08874417.2016.1186524

Ibrahim, A. R. et al. (2018). Bird Counting and Climate Monitoring using LoRaWAN in Swiftlet Farming for IR4.0 Applications. In *2018 2nd International Conference on Smart Sensors and Application, ICSSA 2018* (pp. 33-37). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICSSA.2018.8535955

Idris, A., Abdullah, A. A., & Abd-Rehman, M. (2014). An overview of the study of the right habitat and suitable environmental factors that influence the success of edible bird nest production in Malaysia. *Asian Journal of Agricultural Research, 8*(1), 1-16. https://doi.org/10.3923/ajar.2014.1.16

Kansanga, M. M. et al. (2020). Determinants of smallholder farmers' adoption of short-term and long-term sustainable land management practices. *Renewable Agriculture and Food Systems* (pp. 1-13). Cambridge University Press (CUP). https://doi.org/10.1017/s1742170520000289

Luqman, A., & Van Belle, J. P. (2017). Analysis of human factors to the adoption of Internet of Things-based services in informal settlements in Cape Town. In *2017 1st International Conference on Next Generation Computing Applications, NextComp 2017* (pp. 61-67). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/NEXTCOMP.2017.8016177

Minh, D. D., Hao, N. D., & Lebailly, P. (2020). Adapting to Climate Extreme Events Based on Livelihood Strategies: Evidence from Rural Areas in Thua Thien Hue Province, Vietnam. *Sustainability, 12*(24), 10498. https://doi.org/10.3390/su122410498

Nigussie, Z. et al. (2017). Factors influencing small-scale farmers' adoption of sustainable land management technologies in north-western Ethiopia. *Land Use Policy, 67*, 57-64. https://doi.org/10.1016/j.landusepol.2017.05.024

Othman, A. K. et al. (2009). Wireless sensor networks for swift bird farms monitoring. In *2009 International Conference on Ultra Modern Telecommunications and Workshops*. https://doi.org/10.1109/ICUMT.2009.5345571

ÖZSAYIN, D. (2020). Factors affecting the use of artificial insemination of farmers in dairy farming. *International Journal of Agriculture, Environment and Food Sciences*, 340-347. https://doi.org/10.31015/jaefs.2020.3.13

Pillai, R., & Sivathanu, B. (2020). *Adoption of internet of things (IoT) in the agriculture industry deploying the BRT framework.* https://doi.org/10.1108/BIJ-08-2019-0361

Shee, A., Azzarri, C., & Haile, B. (2019). Farmers' Willingness to Pay for Improved Agricultural Technologies: Evidence from a Field Experiment in Tanzania. *Sustainability, 12*(1), 216. https://doi.org/10.3390/su12010216

Shee, A., Azzarri, C., & Haile, B. (2020). Farmers'willingness to pay for improved agricultural technologies: Evidence from a field experiment in Tanzania. *Sustainability (Switzerland). MDPI AG, 12*(1), 216. https://doi.org/10.3390/SU12010216

Thanh Nhan. (2019). *Phu Yen's Salanganes Nest Association held the first term congress (2018-2023)*. Retrieved April 21, 2020, from http://trithuccongnghe.vn/kinh-te/hoi-yen-sao-tinh-phu-yen-to-chuc-dai-hoi-nhiem-ky-i-2018-2023-107.html

Tun Oo, A., Van Huylenbroeck, G., & Speelman, S. (2017). Determining factors for the application of climate change adaptation strategies among farmers in Magwe District, dry zone region of Myanmar. *International Journal of Climate Change Strategies and Management, 9*(1). https://doi.org/10.1108/IJCCSM-09-2015-0134